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ENVIRONMENTAL FACTORS INFLUENCING DIAMETER DEVELOPMENT WITHIN LOBLOLLY PINE PLANTATIONS IN EAST TEXAS

by

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REPORT NUMBER 23

THE

EAST TEXAS PINE PLANTATION RESEARCH PROJECT

A STUDY OF

LOBLOLLY AND SLASH PINE PLANTATIONS

IN

EAST TEXAS

CENTER FOR APPLIED STUDIES

SCHOOL OF FORESTRY

STEPHEN F. AUSTIN STATE UNIVERSITY

NACOGDOCHES, TEXAS 75962

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This is the twenty-third in a continuing series of reports describing results from the East Texas Pine Plantation Research Project.

Subject and content of each ETPPRP report is regional in scope and of particular interest to loblolly and slash pine plantation owners in East Texas.

Any suggestions, ideas or comments will always be welcomed.

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The author was a graduate student in the School of Forestry. Mr. Malim received his M.S.F. December, 1987. This report is based on some of the results from his thesis research.

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J. David Lenhart
Project Director
January 23, 1989

ENVIRONMENTAL FACTORS INFLUENCING DIAMETER DEVELOPMENT WITHIN EAST TEXAS LOBLOLLY PINE PLANTATIONS

by

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ABSTRACT. An assessment of the role of various environmental factors on the development of four measures of diameter--minimum, arithmetic mean, quadratic mean and maximum--was conducted for loblolly pine (*Pinus taeda* L.) plantations in East Texas. Of 12 environmental factors analyzed, only slope percent, two measures of non-planted vegetation and surface soil pH significantly influenced diameter development.

INTRODUCTION

Diameter development in pine plantations is affected by genetic and environmental factors. Primary environmental factors are climate, topography, soil and biological factors such as animals and vegetation. The interaction between these factors is complex yet intriguing.

An understanding of the factors influencing pine plantation diameter may assist forest managers in deciding which management techniques to implement. Before silvicultural activities such as site preparation and planting, prescribé burning, intermediate and final harvests are scheduled, an idea of the effect of the operation on diameter should be understood.

Another area where diameter development is important is yield estimation. In particular, a diameter distribution yield prediction system has been developed for loblolly and slash pine (*Pinus elliottii* Engelm.) plantations in East Texas (Lenhart 1988). Integral to the yield prediction system is the estimation of minimum, arithmetic mean and quadratic mean diameter. If environmental variables could be added to the yield system, more accurate and precise estimates of future amounts of wood might be obtained.

Recent research in the East Texas Pine Plantation Research Project (ETPPRP) on environmental factors influencing diameter development in East Texas loblolly pine plantations has provided some insights into the complex process (Malim 1987). This paper reports on some of the results from that research.

Information from this paper will be incorporated into another manuscript and submitted to Forest Ecology and Management for consideration for publication.

PLANTATION MEASUREMENTS

The ETPPRP is a long-term comprehensive study of pine plantations in East Texas. Two measurement cycles for the ETPPRP have been completed. For this study, information from 161 ETPPRP model development subplots in loblolly pine plantations at the second measurement cycle (1985-87) was analyzed. Observations from the first measurement cycle could not be analyzed, because a complete set of values for all environmental factors of interest was not available at that time.

Stand factors available for consideration were:

(01) Plantation age-years (A): Number of growing seasons completed since planting.
(02) Plantation height-ft (H): Average height of the ten tallest trees.
(03) Pine trees per acre: Expanded from subplot basis to acre basis.
(04) Minimum diameter-in (DMIN): Smallest diameter.
(05) Mean diameter-in (DMEAN): Arithmetic mean diameter.
(06) Quadratic mean diameter - in (DQMEAN): Quadratic mean diameter.
(07) Maximum diameter-in (DMAX): Largest diameter.

The number of loblolly pine plots is tabulated by plantation age classes as:

Age class (yrs)	Number
3-4	25
5-6	48
7-8	33
9-10	16
11-12	9
13-14	18
15-16	6
17-18	4
19-20	2
Total	161

which represents a sample of relatively young observations.

The following 12 environmental factors were available from the second measurement cycle for hypothesis testing of diameter development. Categories for grouping observations for analysis of variance are listed under each factor along with the sample size for each group:

(01) Landform (LF).

- (a) Stream terrace (10 obs.).
- (b) Upland flat (38 obs.).
- (c) Side slope (57 obs.).
- (d) Upper slope (41 obs.).
- (e) Ridge (15 obs.).

(02) Site preparation method prior to planting (SPM).

- (a) Sheared and chopped. (98 obs.)
- (b) Sheared and piled. (11 obs.)
- (c) Sheared, piled and bedded. (16 obs.)
- (d) Sheared, chopped and burned. (27 obs.)
- (e) Burned only. (9 obs.)

(03) Slope percent (SP).

- (a) 0%. (52 obs.)
- (b) 1-5%. (72 obs.)
- (c) 6-10%. (29 obs.)
- (d) >11%. (8 obs.)

(04) Aspect (AS).

- (a) 0-90° (32 obs.).
- (b) 91-180° (30 obs.).
- (c) 181-270° (24 obs.).
- (d) 271-360° (23 obs.).

Note: Fifty-two of 161 plots had no aspect, because the slope percent was 0.

(05) Depth to subsoil (DSUB).

(a) 0-1.5 ft. (80 obs.)

(b) 1.6-3.0 ft. (40 obs.)

(c) 3.1-4.5 ft. (15 obs.)

(d) 4.6-5.0 ft. (26 obs.)

(06) Surface soil pH (SURPH).

(a) 4.0-5.0. (28 obs.)

(b) 5.1-5.5. (89 obs.)

(c) 5.6-6.5. (44 obs.)

(07) Subsoil pH (SUBPH).

(a) 4.0-5.0. (86 obs.)

(b) 5.1-5.5. (60 obs.)

(c) 5.6-6.5. (15 obs.)

(08) Average annual rainfall (AAR).

(a) 39-45 in. (35 obs.)

(b) 46-50 in. (44 obs.)

(c) 51-65 in. (82 obs.)

(09) Average annual temperature (AAT).

(a) 62.0-65.0^0 F. (39 obs.)

(b) 65.1-67.5^0 F. (113 obs.)

(c) 67.6-70.0^0 F. (9 obs.)

(10) Stems per acre of non-planted vegetation $\geq$ 1.0 inch diameter (SNPVL).

(a) 0-100 (87 obs.)

(b) 101-500 (46 obs.)

(c) >500 (28 obs.)

(11) Stems per acre of non-planted vegetation <1.0 inch diameter (SNPVS).

(a) 0-6000 (103 obs.)

(b) 6001-12000 (47 obs.)

(c) >12000 (11 obs.)

(12) Basal area per acre of non-planted vegetation (BNPV).

(a) 0-5.0 ft^2. (128 obs.)

(b) 5.1-10.0 ft^2. (16 obs.)

(c) >10 ft^2. (17 obs.)

DIAMETER DEVELOPMENT

One-Way Anova of Variance (ANOVA) with specifed covariates was used to test null hypotheses of no differences in diameter development between different groups within each of the 12 environmental factors. Pine trees per acre and plantation age were selected as covariates for each of the four diameter measures. As trees per acre increases, diameter tends to decrease, and as age increases, diameter appears to increase. By using these covariates, more precise ANOVA results were obtained.

ANOVA results are tabulated and discussed on the next 4 pages for each of the 4 measures of diameter.

ENVIRONMENTAL FACTORS INFLUENCING MINIMUM DIAMETER

Group means and ANOVA results for DMIN by each of 12 environmental factors:

Environmental factors	Means by group - in					F-ratio	P-value
	a	b	c	d	e		
LF	0.84	0.90	1.00	0.75	1.01	1.285	0.270
SPM	0.93	0.94	0.85	0.87	0.73	0.351	0.843
SP	0.79	0.99	0.78	1.27		3.053	0.030*
AS	0.85	0.77	0.90	1.13		1.069	0.365
DSUB	0.91	0.89	1.04	0.80		0.600	0.616
SURPH	0.92	0.85	0.99			0.865	0.423
SUBPH	0.87	0.94	0.88			0.303	0.583
AAR	1.01	0.84	0.91			0.719	0.489
AAT	1.06	0.85	0.86			2.178	0.110
SNPVL	0.86	1.09	1.06			1.212	0.300
SNPVS	0.90	0.86	1.04			0.767	0.466
BNPV	0.89	1.13	0.70			2.780	0.057

* Significant at the 5% level.

Of the 12 environmental factors considered, only one--slope percent (SP)-- was statistically significant. One measure of non-planted vegetation--basal area (BNPV)--has a P-value (0.057), that is almost significant at the 5% level. For this particular set of observations, DMIN does not appear to be greatly influenced by forces other than time and associated planted pine trees.

Additional study of DMIN across SP classes appears to indicate that DMIN increases with increasing SP. Perhaps improved drainage on the modest slopes encourages diameter growth. In contrast, DMIN tends to decrease as BNPV increases. Competition from associated vegetation apparently reduces diameter growth.

ENVIRONMENTAL FACTORS INFLUENCING ARITHMETIC MEAN DIAMETER

Group means and ANOVA results for DMEAN by each of 12 environmental factors:

Environmental factors	Means by group - in a	b	c	d	e	F-ratio	P-value
LF	3.38	3.50	3.65	3.10	3.08	2.122	0.080
SPM	3.47	3.46	3.53	3.24	2.75	1.417	0.231
SP	3.15	3.53	3.51	3.84		2.164	0.095
AS	3.30	3.35	3.40	3.70		0.328	0.805
DSUB	3.33	3.52	3.69	3.40		0.700	0.554
SURPH	3.29	3.28	3.78			4.228	0.010**
SUBPH	3.42	3.31	3.82			0.550	0.460
AAR	3.85	3.33	3.37			2.363	0.097
AAT	3.51	3.40	3.57			0.306	0.730
SNPVL	3.27	4.11	3.84			7.316	0.001**
SNPVS	3.39	3.39	3.79			1.121	0.329
BNPV	3.32	3.94	3.60			3.317	0.030*

* Significant at the 5% level. ** Significant at the 1% level.

Of the 12 environmental factors considered, two measures of non-planted vegetation (SNPVL and (BNPV) and the pH of the surface soil (SURPH) were statistically significant. The associated vegetation surrounding the planted loblolly pine trees appears to influence mean diameter development. Availability of essential nutrients tends to increase as pH increases (Pritchett and Fisher 1987).

Further study indicates that DMEAN does increase with increasing SURPH. Interestingly, DMEAN appears to be positively associated with increasing levels of non-planted vegetation. In these young plantations, the positive effect of modified microclimate is apparently greater than the negative competition effect (Malim 1987).

LITERATURE CITED

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